The effect of essential oils from the coriander and fennel fruits on the weight and hematological parameters of piglets during the rearing period

Yuri Volchenkov*, and *Konstantin* Ostrenko

All-Russian Scientific Research Institute of Physiology, Biochemistry, and Animal Nutrition – branch of the Federal State Budgetary Scientific Institution "Federal Research Center of Animal Husbandry - All-Russian Research Institute of Animal Husbandry named after Academician L.K. Ernst", VNIIFBIP, 249013, Borovsk, Kaluga region, Russian Federation

Abstract. The article presents data on the study of weight and hematological parameters of piglets in the post-weaning period against the background of the use of coriander and fennel essential oils. The physiological experiment was carried out on 15 crossbreed young hogs (F1:(D*L)) with an initial live weight of 11.95-12.56 kg at the age of 45 days. The duration of the experiment is 80 days. The inclusion of fennel and coriander essential oils in the diet made it possible to increase the average daily gain by 4.45-6.23%. Morphological parameters of blood increased in growing young animals: erythrocytes by 1.46-2.93%, hemoglobin by 7.86-8.71%.

1 Introduction

Farm animals in the early period of ontogenesis are most often exposed to environmental factors. The high susceptibility of young animals in combination with the technological processes of raising directly affects the general condition of a living organism. Early weaning, unfavorable maintenance conditions, poor-quality feeding lead not only to an increase in the incidence rate, but also, in extreme cases, to death.

The period of weaning of piglets from a sow is often accompanied by diarrheal syndrome, which is relieved with the help of antimicrobial agents. To prevent the mass morbidity of weaned piglets and reduce the mortality rate of livestock, feed antibiotics are used. Their uneven distribution over the feed volume leads to a violation, which increases the risk of receiving an antibiotic in a non-therapeutic dose. Improper use of feed antibiotics in animal husbandry leads to mutation of microorganisms and the appearance of resistant forms [1].

Antimicrobials in pig farming are used not only for medicinal purposes, but also as growth stimulants. The stimulating effect of antibiotics on pig growth is explained by the suppression of the catabolic activity of the microflora and a decrease in the level of

* Corresponding author: y.volchenkov@mail.ru

intestinal amines. Violation of the use of antibiotic growth stimulants (AGS) in the technological cycle of pig rearing can lead not only to antibiotic resistance, but also to the detection of residual amounts of the drug in the resulting products. In the future, there is a risk of transmission of resistant forms of microorganisms through meat to humans [2-3].

For the first time, restrictions on the use of feed forms of antibiotics were adopted in the European Union in 2006. To prevent antimicrobials from entering meat products, the U.S. SCA, which regulates the quality of food and medicines, in 2016 took a number of measures restricting the use of antibiotic growth stimulants in animal feeding. In 2017, the Ministry of Health of Canada passed a law restricting the use of antibiotics in animal feeding [4].

Realizing the importance of providing the population with safe livestock products, the Government of the Russian Federation approves draft laws aimed at the agricultural sector of the country. In August 2018, Federal Law No. 280 "On Organic Products and on Amendments to Certain Legislative Acts of the Russian Federation" was adopted. In January 2020, the Russian Food Security Doctrine was approved, aimed at obtaining high-quality and safe products. In December 2021, a bill was approved to limit the introduction of feed antibiotics into the diets of farm animals, which will enter into force in March 2025.

In this regard, the modern pig industry of the country is in search of economically profitable alternatives to feed antimicrobials. Thus, phytobiotic products of plant origin can serve as an alternative to modern forms of feed antibiotic growth stimulants.

According to the literature, phytobiotics are natural additives of plant origin that have not only antibiotic activity, but also anti-inflammatory, antiviral, antifungal, and immunostimulating properties. The multidirectional action of phytogenic additives will allow them to be used in pig feeding to stabilize the intestinal microflora, stimulate appetite, and improve the digestibility of feed, which will positively affect the productivity and quality of the food products produced [5-6].

Depending on the chemical composition and biological activity, phytobiotics are divided into the following groups: herbs, spices, resins, and essential oils (EO). Volatile lipophilic compounds - essential oils obtained by cold pressing, alcohol and steam distillation, have significant antimicrobial and immunostimulating properties [7-9]. In the countries of the European Union, the production of plant-based drugs reaches significant volumes. The Russian Federation currently has great potential for the cultivation of ethereal plants.

The heart of essential oil crops is the Republic of Crimea, which has more than half of all the cultivated areas of Russian ethereal plants. A number of studies have proved that EO antimicrobial activity depends on the geographical location. The climate of the Crimean Peninsula has a favorable effect on essential oil crops, which will make it possible to obtain a competitive domestic product of good quality with a high degree of activity.

Most of the acreage of essential oil crops is 90% occupied by coriander, an annual plant of the parsley family. Coriander fruits contain from 0.7 to 1.2% EO, the main components of which are linalool (60-80%) and geraniol (up to 5%). The active components of EO of coriander fruits have antimicrobial and antifungal activity, anti-inflammatory, and immunostimulating properties. A similar nature of the action of the main components is inherent in a perennial (biennial) plant of the Apiaceae family – fennel. Fennel EO contains components such as anethol (65-69%) and fenchone (up to 5%) [10].

The versatile activity of coriander and fennel EO allows them to be used as an alternative feed additive in the technological cycle of pig rearing.

The purpose of the study was to conduct an experiment to study the effect of essential oils of coriander and fennel on hematological and weight parameters of piglets during the rearing period.

2 Materials and methods of research

The study was conducted on the basis of the Laboratory of Immunobiotechnology and Microbiology and the vivarium of the All-Russian Scientific Research Institute of Physiology, Biochemistry, and Animal Nutrition – branch of the FSBEI Federal Research Center for Animal Husbandry named after Academician L.K. Ernst. According to the pairs-analogues principle, 15 crossbred young hogs (F1:(D*L) at the age of 45 days with an initial live weight of 11.95-12.56 kg, purchased from LLC ECO FARM Klimovskaya (Kaluga region, Russia), were selected and 3 groups of animals of 5 heads each were formed – 2 experimental and 1 control. The duration of the study was 80 days.

According to the scheme (Table 1) of the study, the control group received the basic diet (SK-4) without the addition of additional feed additives. Animals of the experimental groups were injected with coriander and fennel EO by aerosol spraying onto feed pellets followed by thorough mixing. The daily dose of EO was 0.05 ml per kg of body weight.

The sanitary condition of the premises, the conditions of maintenance and the composition of complete compound feed for all groups of animals were identical and were within the limits of zoohygienic standards.

Table 1. Physiological experiment scheme.

Group	Amount of heads	Feeding characteristics
Scientific and economic experience		
control	5	Complete feed (CF)
1st (experimental)	5	CF + 0.05 ml coriander EO / kg a.w.
2st (experimental)	5	CF + 0.05 ml fennel EO / kg a.w.

During the study, body weight was considered – the absolute and average daily gain. During the formation of the groups, a control weighing was carried out using VSP4-ZhsO livestock scales (Nevsky Scales, Russia), further live weight control was carried out on a monthly basis. As part of the study, on day 1 and further on day 30, blood samples were taken from the jugular vein into vacuum tubes K_2EDTA of 4 ml for hematological analysis using the Dymind DF50 Vet automatic hematology analyzer (Dymind, China). Hematological studies of venous blood include the following indicators: erythrocytes, leukocytes, hemoglobin, hematocrit.

The digital material obtained in the course of the study was statistically processed using the method of variation statistics according to the Student's t-criterion, using the Microsoft Excel program within the following significance levels: * - $P \leq 0.05$.

3 Results and Discussion

The main active ingredients of coriander and fennel EO are linalool and anethol, which have antimicrobial properties. Essential oils are aimed at various purposes in the microbial cell and are capable of destabilizing and permeating bacterial membranes. As a result, ions are released from the cell into the external environment, followed by a change in the proton gradient and depletion of the intracellular ATP reserve. The antimicrobial activity of the studied EO makes it possible to prevent diarrhea, which often occurs against the background of technological stress.

The experimental data presented in Table 2 indicate an intensive increase in body weight against the background of the use of coriander and fennel EO.

Table 2. Growth dynamics of piglets against the background of the use of coriander and fennel essential oils (M±m, n=5).

Indicator	Group		
	control	1st experimental	2nd experimental
Days of experiment	The duration of the study is 80 days		
Live weight at the beginning of the experiment, kg	12.26±0.3	12.16±0.24	12.14±0.19
Live weight at the end of the period, kg	57.14±0.79	59.88±1.20*	59.04±1.03*
Absolute gain in live weight, kg	44.88±1.01	47.72±1.03*	46.9±1.12*
Average daily increase, g	561±12	596±12*	586±14
Live weight in % to the control	100	104.79	103.32

*Note: * (P ≤ 0.05) according to the t-criterion when compared with the control group*

According to the data in table 2, it can be concluded that before the start of the research, the weight indicators of piglets did not significantly differ. At the end of the experiment, piglets of the 1st experimental group receiving coriander EO had a maximum absolute increase in live weight relative to the control - 6.32% *(P≤0.05)*, piglets from the 2nd experimental group – 4.5% *(P≤0.05)*. At the end of the growing period, the difference in absolute and average daily growth between the control and the 1st experimental group was 2.84 kg and 35 g *(P≤0.05)*, between the control and the 2nd experimental group - 2.02 kg and 25 g.

Thus, based on the results of the conducted physiological experiment, it can be concluded that coriander and fennel EO have a positive effect on the growth dynamics and average daily gains of piglets in the post-weaning period and the rearing period.

The studied morphological parameters (Table 3), with the exception of leukocytes in the second experimental group, were within the reference values. The 1st experimental group did not differ significantly in relation to the control. In the 2nd experimental group, the number of leukocytes increased by 20.2% *(P≤0.05)*, which indicates a small leukocytosis. An increase in leukocytes in piglets receiving fennel EO may indicate the formation of natural resistance against the background of intensive growth during the rearing period. According to literature data, piglets in the post-weaning period are characterized by minor leukocytosis, which gradually decreases at the age of 4-6 months [11].

The tendency to increase the level of red blood cells in the blood is observed in both experimental groups - the number of red blood cells in the 2nd experimental group increased by 2.93%, in the 1st by 1.46% compared to the control.

The amount of hemoglobin in the blood of experimental animals, compared with control animals, is significantly different and is slightly above the upper limit of the norm. As a percentage, the hemoglobin level in the 1st experimental group increased by 7.86% *(P≤0.05)*, in the 2nd by 8.71% *(P≤0.05)*. Studies have been conducted that pigs with a higher hemoglobin content in the blood had a higher slaughter yield [12].

The hematocrit in the blood of piglets of the two experimental groups was significantly higher than that of the control group by 11.2% and 12.4% *(P≤0.05)*.

It follows from the obtained results of physiological experiment that coriander and fennel EO used as a feed additive have a positive effect on the level of metabolic processes, transport and protective functions of blood in piglets during the rearing period.

Table 3. Morphological composition of piglet blood against the background of the use of coriander and fennel essential oils (M±m, n=5).

Indicator	Group		
	Control	1st experimental	2nd experimental
Erythrocytes, 10^{12}/l	6.81±0.17	6.91±0.31	7.01±0.24
Leukocytes, 10^{9}/l	19.8±0.82	20.02±0.90	23.8±0.79*
Hemoglobin, g/l	117±3.74	126.2±2.77*	127.2±2.38*
Hematocrit, %	34.22±1.10	38.06±1.49*	38.48±1.47*

*Note: *(P≤0.05), according to the t-criterion when compared to the control group.*

4 Conclusions

The use of coriander and fennel essential oils in the composition of complete compound feed has a positive effect on the dynamics of absolute and average daily increases due to stabilization of the microflora and increased feed conversion. The morphological parameters of the blood of experimental groups of animals indicate an improvement in the general physiological state, intensification of metabolic processes, and an increase in the blood transport and protective functions.

Thus, the inclusion of essential oils from the fruits of coriander and fennel in the diet of young pigs contributes to an increase in productivity during the post-weaning period of rearing. The use of essential oils in domestic pig farming is a promising, safe, and environmentally beneficial direction, as a result of which further research on this topic is necessary.

References

1. F.A. Omonijo, L. Ni, J. Gong, Q. Wang, L. Lahaye, C. Yang, AnimNutr., **4(2),** 126-136 (2018). doi: 10.1016/j.aninu.2017.09.001
2. R.B. Nhara, U. Marume, C.W.T. Nantapo, Animals (Basel), **14,** 762 (2024). doi: 10.3390/ani14050762.
3. W. Windisch, K. Schedle, C. Plitzner, A. Kroismayr, J Anim Sci., **86,** 140-8 (2008). doi: 10.2527/jas.2007-0459.
4. Z. Zeng, S. Zhang, H. Wang, X. Piao, J Anim Sci Biotechnol., **6,** 7 (2015). doi: 10.1186/s40104-015-0004-5.
5. Z.X. Rao, M.D. Tokach, J.C. Woodworth, J.M. DeRouchey, R.D. Goodband, J.T. Gebhardt, Animals (Basel), **13(2),** 200 (2023), doi: 10.3390/ani13020200.
6. M. Bellerose, P. Fravalo, I. Mainville, Y. Arcand, A. Thibodeau, Acta Vet Scand., **65(1),** 17 (2023), doi: 10.1186/s13028-023-00679-w.
7. B.C. Zhao, T.H. Wang, J Chen, B.H. Qiu, Y.R. Xu, Q. Zhang, J.J. Li, C.J. Wang, Q.F. Nie, J.L. Li, Porcine Health Manag., **9(1),** 24 (2023). doi: 10.1186/s40813-023-00317-x.
8. M.A. Salem, E.G. Manaa, N. Osama, N.M. Aborehab, M.F. Ragab, Y.A. Haggag, M.T. Ibrahim, D.I. Hamdan, Sci Rep., **12(1),** 6578 (2022). doi: 10.1038/s41598-022-10494-4.
9. C. Yang, M.A. Chowdhury, Y. Huo, J. Gong, Pathogens, **4(1),** 137-156 (2015), doi: 10.3390/pathogens4010137.

10. A.V. Volchenkova, A.N. Ovcharova, K.S. Ostrenko, N.V. Nevkrytaya, Problems of biology of productive animals, **2,** 56-63 (2024). doi: 10.25687/1996-6733.prodanimbiol.2024.2.56-63.
11. O.Y. Rudishin, S.V. Burtseva, I.D. Semenova, D.B. Lytkina, Promising pig farming: Theory and practice, **3** (2011).
12. L.S. Gimadeeva, I.V. Gusev, V.A. Ryzhkov, R.A. Rykov, News of OSAU, **5,** 148-151 (2015).